

What is claimed is:

1. An apparatus for applying a clamping force against a surface of a work piece, the apparatus comprising:

at least one elongated member adapted to be positioned proximate the surface of the work piece, the at least one elongated member including at least one portion adapted to be secured to substantially prevent movement of the elongated member relative to the surface; and

a plurality of pressure applying devices operatively attached to the at least one elongated member and disposed therealong, each pressure applying device including a contact member moveable relative to the elongated member and adapted to engage the surface of the work piece, and a resilient member operatively coupled to the contact member and to the elongated member, the resilient member biasing the contact member away from the elongated member to apply a clamping force to the surface of the work piece.

2. The apparatus of Claim 1 wherein the elongated member includes a first end portion and a second end portion adapted to be secured to substantially prevent movement of the elongated member relative to the surface.

3. The apparatus of Claim 1 wherein the resilient member includes a spring.

4. The apparatus of Claim 1 wherein the resilient member includes a resilient material.

5. The apparatus of Claim 4 wherein the resilient material includes at least one of a rubber and a compressible plastic.

6. The apparatus of Claim 1, wherein at least one pressure applying device applies at least one of a hydraulic pressure and a pneumatic pressure.

7. The apparatus of Claim 1, wherein the at least one elongated member includes a substantially straight segment.

8. The apparatus of Claim 1, wherein the at least one elongated member includes a curved segment.

9. The apparatus of Claim 1, wherein the elongated member includes a segment including an angle.



10. The apparatus of Claim 1, wherein the contact member includes at least one pad arranged to apply the clamping force against the surface.

11. The apparatus of Claim 10, wherein the at least one pad includes a TEFLON<sup>®</sup> layer.

5 12. The apparatus of Claim 1, wherein the plurality of pressure applying devices includes a plurality of resiliently loaded pads attached along a span of the elongated member over the surface and arranged to apply the clamping force to the surface at a plurality of locations.

13. The apparatus of Claim 1, wherein the at least one elongated member includes first and second elongated portions.

10 14. The apparatus of Claim 13, wherein the first and second elongated portions comprise non-parallel elongated portions.

15. The apparatus of Claim 14, wherein the first and second elongated portions comprise a cruciform shape.

15 16. An apparatus for applying a clamping force against a surface of a work piece, the apparatus comprising:

a first elongated member adapted to be positioned proximate the surface of the work piece, the first elongated member adapted to be secured to substantially prevent movement of the first elongated member relative to the surface;

20 a second elongated member adapted to be positioned proximate the surface of the work piece, the second elongated member adapted to be secured to substantially prevent movement of the second elongated member relative to the surface, the first and second elongated members defining a slot therebetween; and

25 a plurality of pressure applying devices distributed along the first and second elongated members, each pressure applying device being moveably coupled to a respective one of the first and second elongated members and including a contact member moveable relative to the respective one of the elongated members and adapted to engage the surface of the work piece, and a resilient member operatively coupled to the contact member and to the respective one of the elongated members, the resilient member biasing the contact member away from the respective one of the elongated members to apply a clamping force to the surface of the work piece.

30



25315

PATENT TRADEMARK OFFICE

17. The apparatus of Claim 16, wherein at least one of the pressure applying devices includes a spring.

18. The apparatus of Claim 16, wherein at least one of the resilient members includes a  
5 resilient material.

19. The apparatus of Claim 18 wherein the resilient material includes one of rubber and compressible plastic.

20. The apparatus of Claim 16 wherein the at least one of the resilient members applies the clamping force utilizing one of hydraulic pressure and pneumatic pressure.

10 21. The apparatus of Claim 16 wherein the first elongated member includes a first substantially straight segment, and the second elongated member includes a second substantially straight segment, and the first substantially straight segment is positioned proximate and parallel to the second substantially straight segment.

15 22. The apparatus of Claim 16 wherein the first elongated member includes a first curved segment, and the second elongated member includes a second curved segment, and the first curved segment is positioned proximate and parallel to the second curved segment.

20 23. The apparatus of Claim 16 wherein the first elongated member includes a first segment including an angle, and the second elongated member includes a second segment including an angle, and the first segment is positioned proximate and parallel to the second segment.

24. The apparatus of Claim 16 wherein the at least one of the contact members includes at least one pad arranged to distribute the clamping force against the object.

25. The apparatus of Claim 16 wherein the at least one pad includes a TEFLON<sup>®</sup> layer.

25 26. The apparatus of Claim 16, wherein the first elongated member includes first and second elongated portions, and the second elongated member includes third and fourth elongated portions.



25315

PATENT TRADEMARK OFFICE

27. The apparatus of Claim 26, wherein the first and second elongated portions comprise non-parallel elongated portions, and the third and fourth elongated portions comprise non-parallel elongated portions.

5 28. The apparatus of Claim 26, wherein the first and second elongated portions comprise a cruciform shape, and the third and fourth elongated portions comprise a cruciform shape.

29. An apparatus for clamping a work piece during a manufacturing process, the apparatus comprising:

10 at least one elongated member adapted to be positioned proximate a surface of the work piece, the at least one elongated member including at least one portion adapted to be secured to substantially prevent movement of the elongated member relative to the surface; and

15 a plurality of pressure applying devices operatively attached to the at least one elongated member and disposed therealong, each pressure applying device including a contact member moveable relative to the elongated member and adapted to engage the surface of the work piece, and a resilient member operatively coupled to the contact member and to the elongated member, the resilient member biasing the contact member to apply a clamping force to the surface of the work piece.

20 30. The apparatus of Claim 29 wherein the resilient member includes a spring.

31. The apparatus of Claim 30 wherein the resilient member includes a resilient material.

32. The apparatus of Claim 30 wherein the contact member is adapted to project across at least a portion of the surface of the work piece.

25 33. An apparatus for clamping a work piece to a frame during a manufacturing process, the apparatus comprising:

at least one cradle adapted to support the frame;

30 at least one elongated member adapted to be positioned proximate a surface of the work piece, the at least one elongated member including first and second end portions adapted to be secured to substantially prevent movement of the elongated member relative to the surface; and



a plurality of pressure applying devices operatively attached to the at least one elongated member and disposed therealong, each pressure applying device including a contact member moveable relative to the elongated member and adapted to engage the surface of the work piece, and a resilient member operatively coupled to the contact member and to the elongated member, the resilient member biasing the contact member away from the elongated member to apply a clamping force to the surface of the work piece.

34. The apparatus of Claim 33 wherein the resilient member includes a spring.

35. The apparatus of Claim 33 wherein the resilient member includes a resilient material.

36. The apparatus of Claim 33, wherein at least one of the plurality of pressure applying devices applies at least one of a hydraulic pressure and a pneumatic pressure.

37. The apparatus of Claim 33, wherein the at least one elongated member includes first and second elongated portions.

38. The apparatus of Claim 37, wherein the first and second elongated portions comprise non-parallel elongated portions.

39. The apparatus of Claim 38, wherein the first and second elongated portions comprise a cruciform shape.

40. A method for performing a manufacturing operation on a work piece, comprising:  
providing at least one elongated member having a plurality of contact members distributed therealong and projecting therefrom;  
positioning the at least one elongated member proximate a surface of the work piece;  
engaging the plurality of contact members distributed along the elongated member with the surface of the work piece; and  
resiliently applying a clamping force to the surface using the plurality of contact members distributed along the elongated member.

41. The method of Claim 40, wherein providing at least one elongated member having a plurality of contact members distributed therealong and projecting therefrom includes



25315  
PATENT TRADEMARK OFFICE

- 18 -

BING-1-1023APP

BLACK LOWE & GRAHAM <sup>PLLC</sup>

816 Second Avenue  
Seattle, Washington 98104  
206.381.3300 • F: 206.381.3301

providing an elongated bar having a plurality of contact pads projecting therefrom, each contact pad being resiliently biased outwardly from the elongated bar by a biasing member.

42. The method of Claim 40, wherein providing at least one elongated member having a plurality of contact members distributed therealong and projecting therefrom includes providing an elongated bar having a plurality of contact pads projecting therefrom, each contact pad being resiliently biased outwardly from the elongated bar by a spring member at least partially disposed within a concavity formed in the elongated bar.

43. The method of Claim 40, wherein providing at least one elongated member having a plurality of contact members distributed therealong and projecting therefrom includes providing first and second elongated members, the first and second elongated members being substantially parallel and forming a slot therebetween.

44. The method of Claim 40, wherein providing at least one elongated member having a plurality of contact members distributed therealong and projecting therefrom includes providing first and second elongated members, the first and second elongated members being substantially non-parallel.

45. The method of Claim 40, further comprising securing the at least one elongated member in position relative to the surface of the work piece.

46. The method of Claim 45, wherein securing the at least one elongated member in position relative to the surface of the work piece includes fixedly securing a first end and a second end of the at least one elongated member relative to the surface of the work piece.

47. The method of Claim 40, further comprising working the work piece.

48. The method of Claim 41, wherein working the work piece includes bonding at least a portion of the work piece.

49. The method of Claim 48, wherein bonding includes friction stir welding.

50. A method for performing a manufacturing operation on a work piece, the method comprising:

bridging at least a portion of the work piece proximate to the work piece forming a span;

forming a slot including two sides through a section of the span;



25315

PATENT TRADEMARK OFFICE

resiliently applying force to the work piece from a plurality of contact members distributed along the span proximate to the two sides of the slot; working the work piece through the slot.

51. The method of Claim 50, wherein working includes bonding at least a portion of the work piece.

52. The method of Claim 51, wherein bonding includes friction stir welding.

53. A method for aircraft assembly, the method comprising:  
supporting a portion of an aircraft frame  
positioning at least one skin segment over the frame;  
10 bridging at least a part of the portion of the frame and at least part of the at least one skin segment, forming a span;  
forming a slot including two sides through a section of the span;  
resiliently clamping the at least one skin segment to the portion of the frame by  
applying clamping force from a plurality of contact members distributed along  
15 the span proximate to the two sides of the slot;  
working the work piece through the slot.

54. The method of Claim 53, wherein working includes bonding the at least one skin segment to the portion of the frame.

55. The method of Claim 54, wherein bonding includes friction stir welding.

20 56. The method of Claim 53, wherein working includes bonding the at least one skin segment to at least one second skin segment.

57. The method of Claim 56, wherein bonding includes friction stir welding.



25315  
PATENT TRADEMARK OFFICE